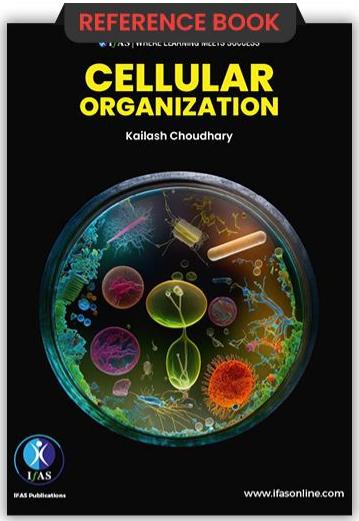
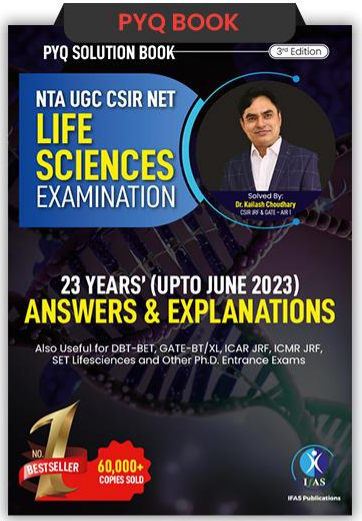
Don't wait for the opportunity. Create it.

CSIR NET – Life Science

Unit 2: Cellular Organization

L2 | **Plasma membrane**

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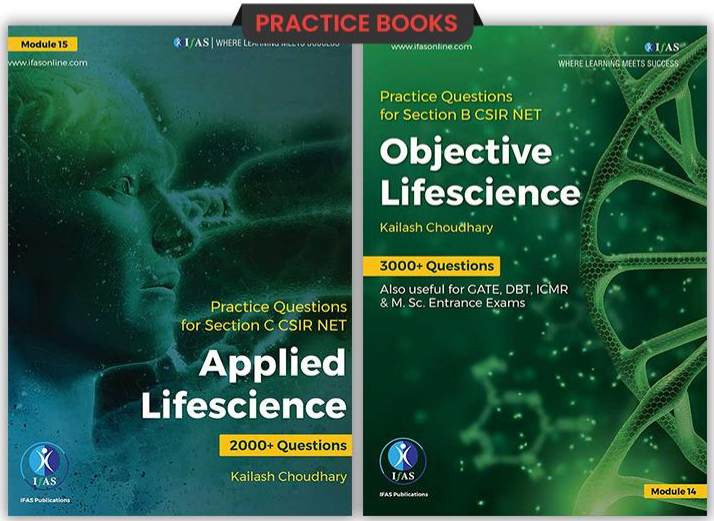

IfAS

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Points to be covered in this Lecture

- Plasma Membrane-lipids
- Chemical composition of membrane lipids
- Fippase/floppase/scramblase
- Tm of fatty acid and membrane lipids
- Cholesterol

Plasma Membrane

- Limitating Structure arround cell
- act as permeability barrear
- keeps Internal Environment Separate from External Environment
- P.M is Semipermiable For those molecule that can Pass Through lipid bilayer
- P.M is Selectively Permiable For those molecule that can not Pass Through lipid bilayer

- PM. → Role in Signal Transduction
  - ↳ Contain various Receptor For Signal molecule
- Helps in cell Division
- Helps in cell to cell Recognition

Chemical Composition - of P.M

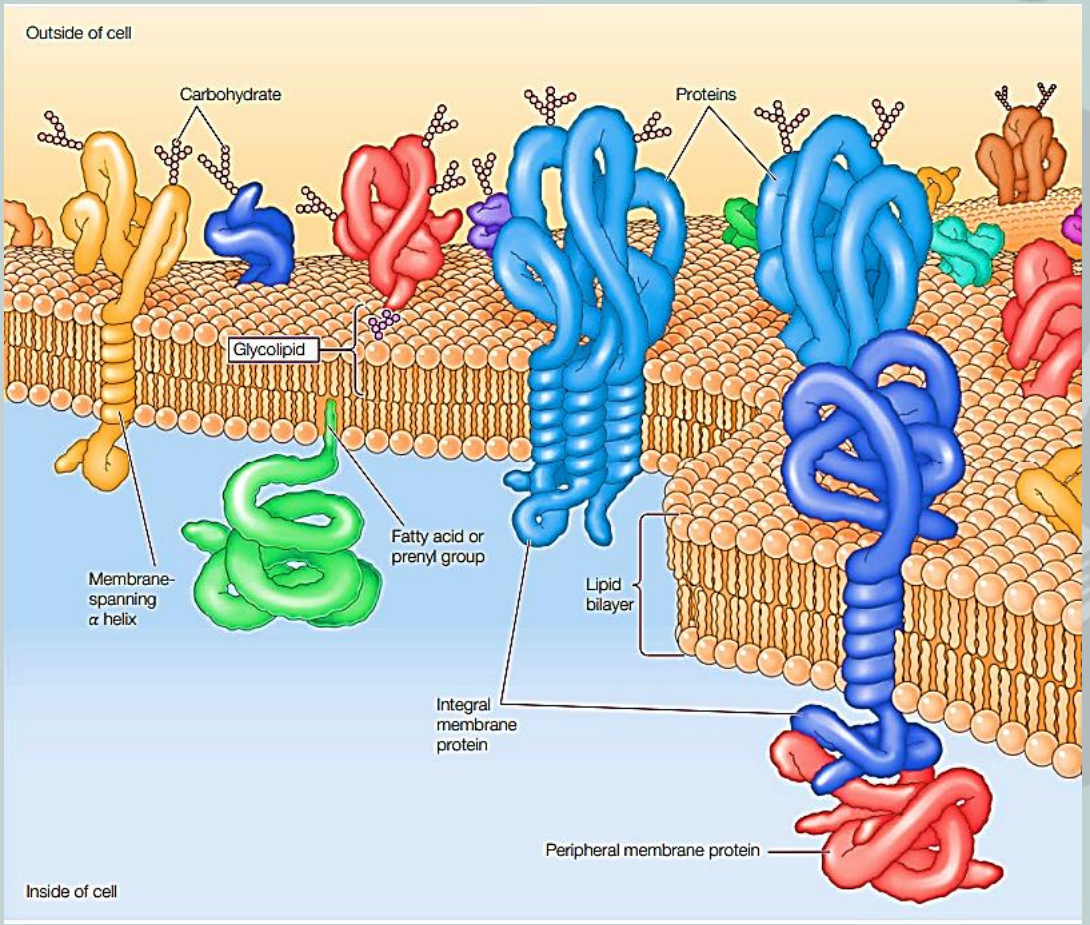
→ Mature RBC - is model cell to study P.M.

Reason - Lack → cell organelles

P.M

Protein	Lipid	carbohydrate
RBC - 49 %	43 %	≈ 8 %
mito - 80 %	18 %	≈ 2 %
mylene sheath. 20 %	80 %	≈ 1 %

Plasma membrane



Jonathan Singer
Garth Nicolson (1972):
Fluid mosaic model
Membrane is two dimensional fluids with proteins inserted into lipid bilayers

What are Lipids ?

↓

Amphipathic molecule [Polar a/w/a Non Polar]

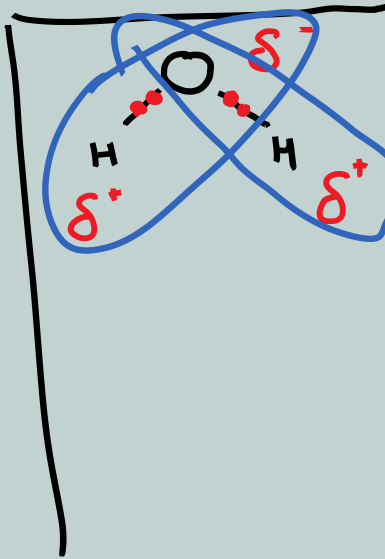
Polar → K/a Hydrophillic

Non Polar → Hydrophobic

- Polar (Head)
- Non Polar (Tail) → Amphipathic molecule

↓

- Hydrocarbon Chain



What are Membrane Lipids ?

Membrane Lipids

Consist around 50% of membrane and plays role of permeability

PHOSPHOLIPIDS

- Phosphatidylcholine
- Phosphatidylethanolamine
- Phosphatidylserine
- Phosphatidylthreonine
- Phosphatidylinositol
- Phosphatidylglycerol
- Diphosphatidylglycerol (cardiolipin)
- Sphingomyelin (a sphingolipid)

GLYCOLIPIDS

- Cerebrosides (galactocerebroside)
- Gangliosides

STEROLS

- Cholesterol
- Campesterol, Sitosterol, Stigmasterol — Phytosterols
- Ergosterol
- Hopanoids

Sterol like substance found in bacteria

membrane lipid

Polar Head (Poly Hydroxy Alcohol)

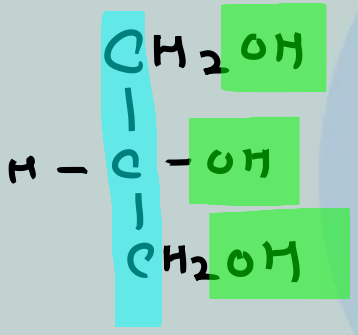
Non Polar → (Fatty acyl chain)

↓

Hydrocarbon chain

Polyhydroxy Alcohols

eg - Glycerol → most common polyhydroxy alcohol found in membrane lipid



+ Fatty acyl chain

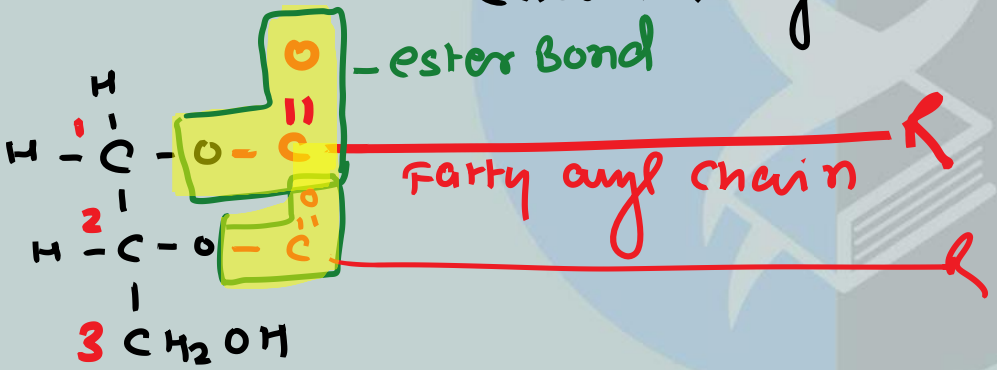
Fatty Acids

↳ Hydrocarbon Chain ($CH_2-CH_2-CH_2\cdots\cdots\cdots CH_3$)

↓

14C , 16C , 18C , 20C

Chain length ↑ > Non-Polarity ↑



Fatty Acyl chain

Saturated F.A

↓

Only Single Bond +nt

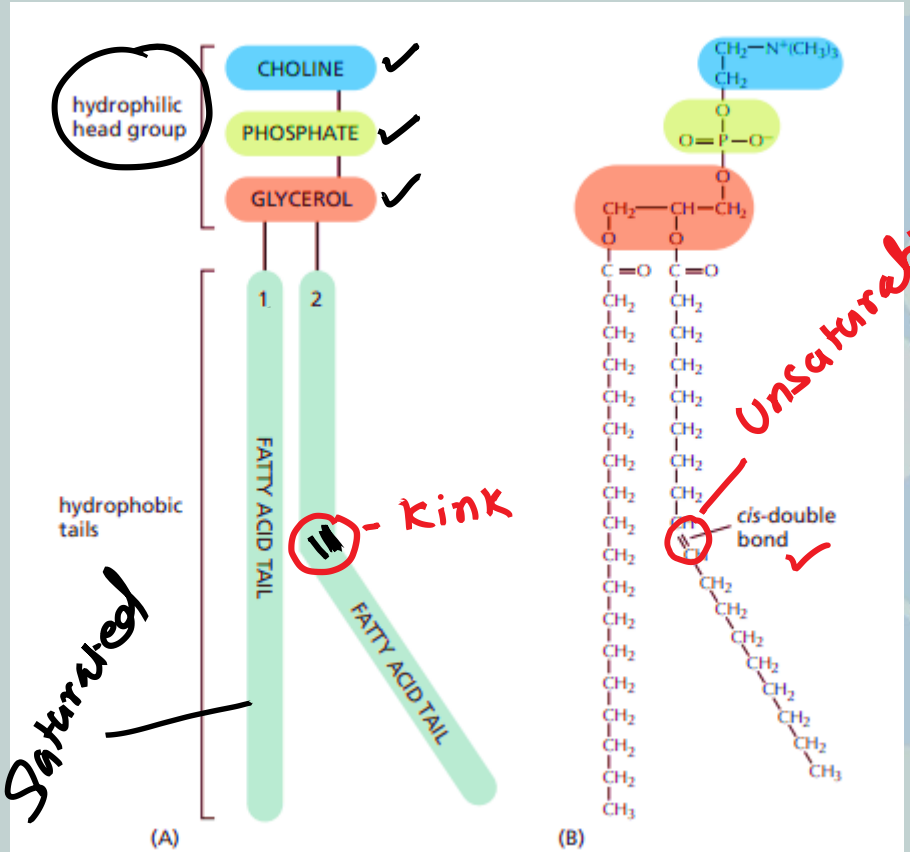
Unsaturated F.A

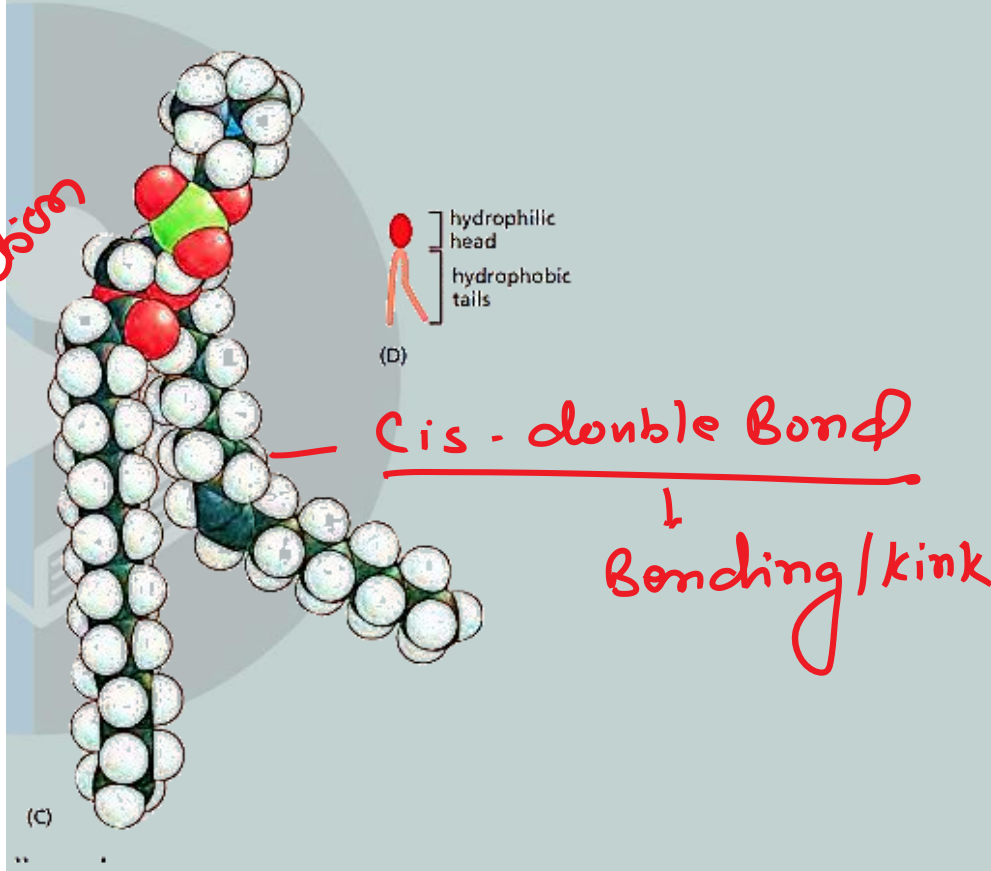
↓

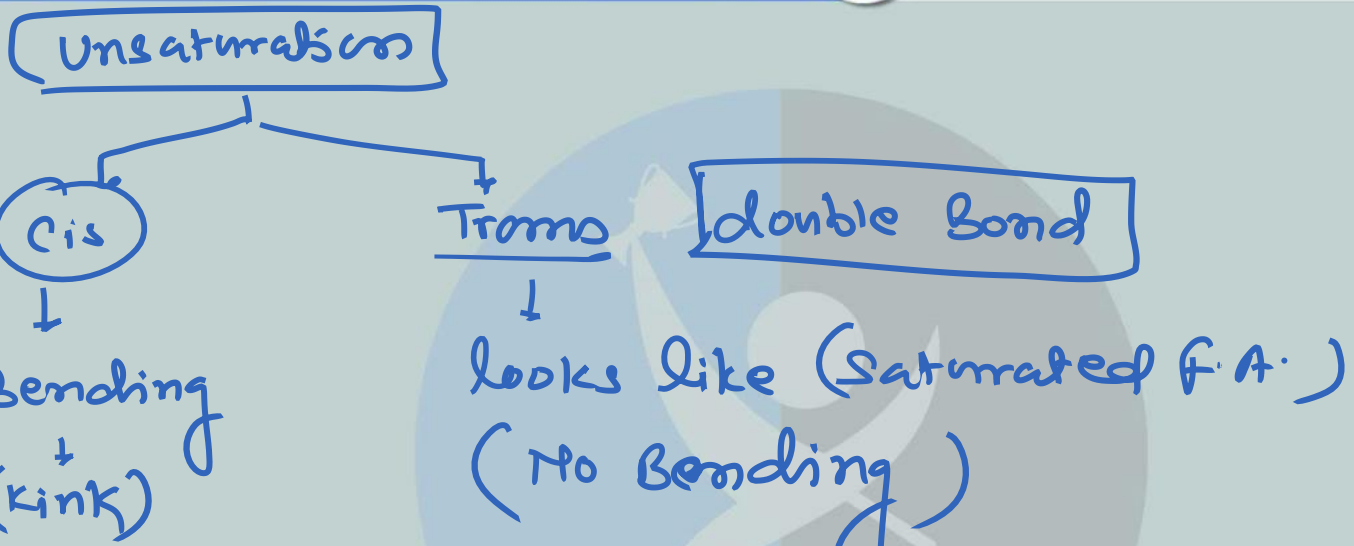
• doble Bond +nt

Saturated Fatty Acids

Unsaturated Fatty Acids






Unsaturated
Cis
Bending
(Kink)
Trans
double bond
looks like (Saturated F.A.)
(No Bending)

Lipids provide fluidity to the membrane

↳ due to movement in lipid molecule

Tm of Fatty Acids and Membrane Lipids

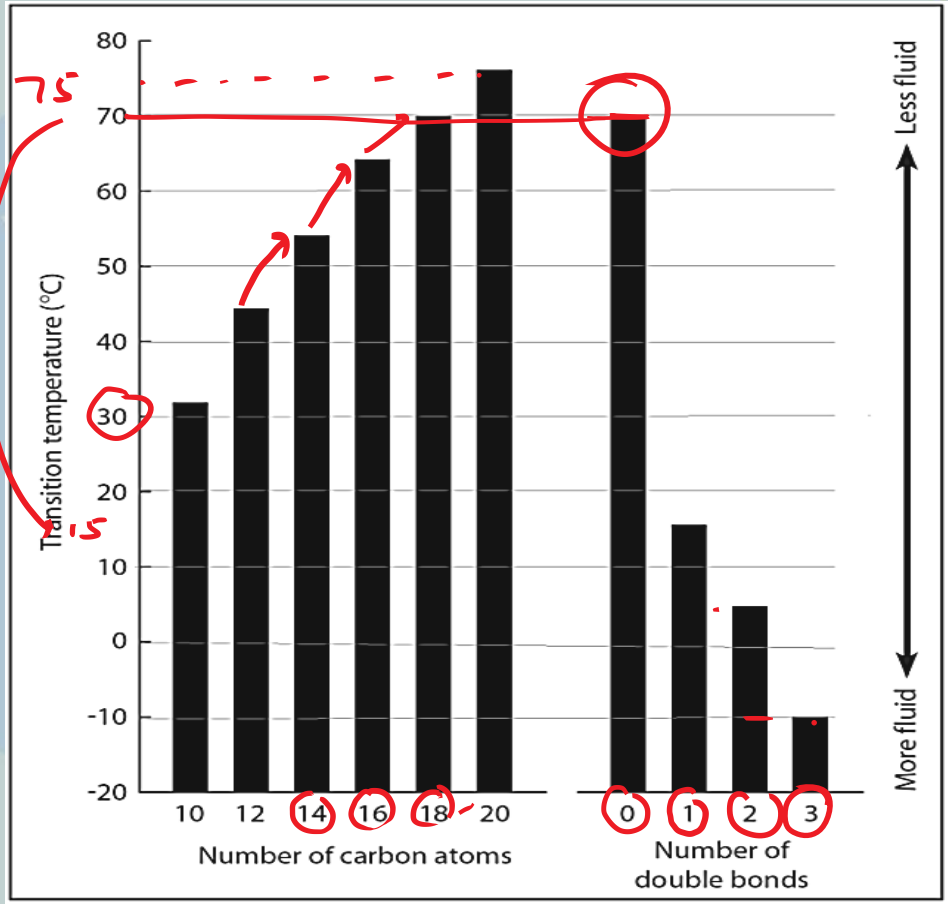
Transition temp (melting temp)

↳ Temp. at which 50% of lipids are present in Gel form

and 50% " " " " Sol form

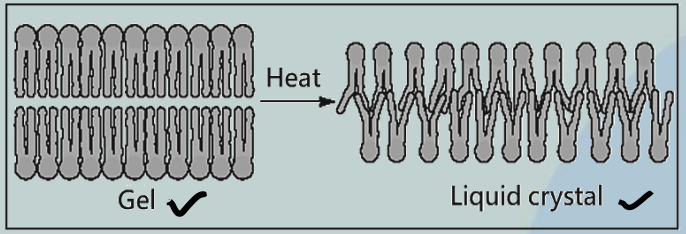
Tm is affected by

1. Chain length
2. No. of unsaturation (Double Bond)



- Tm $\propto$ F.A. chain length
- Tm $\propto \frac{1}{\text{degree of unsaturation}}$

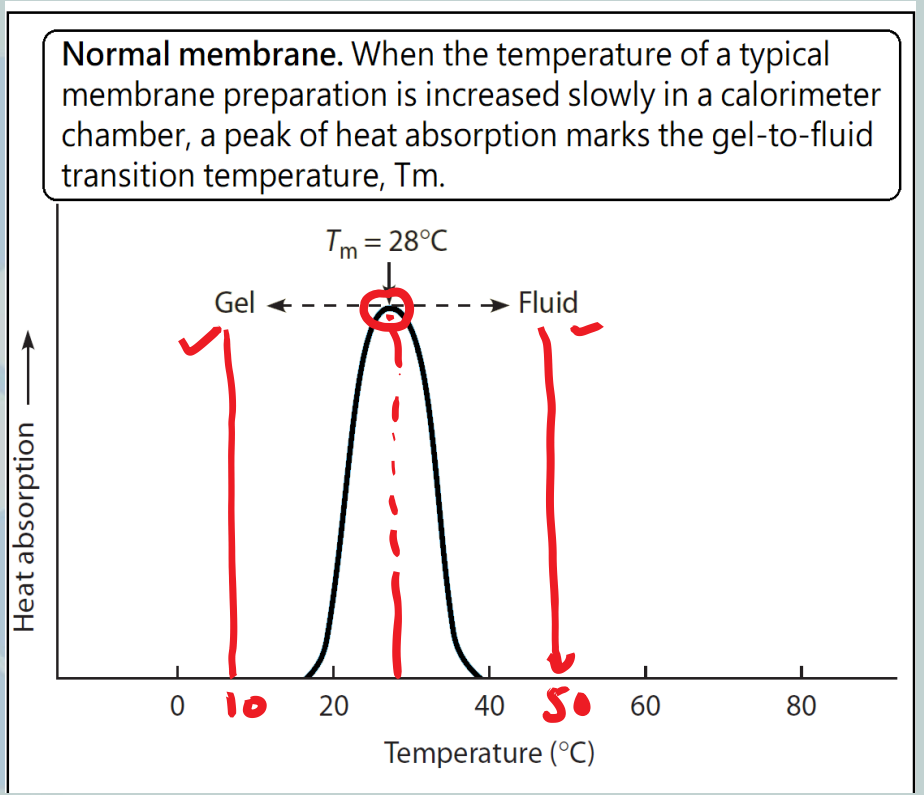
Transition temperature of different lipids



Differential scanning calorimetry

↓

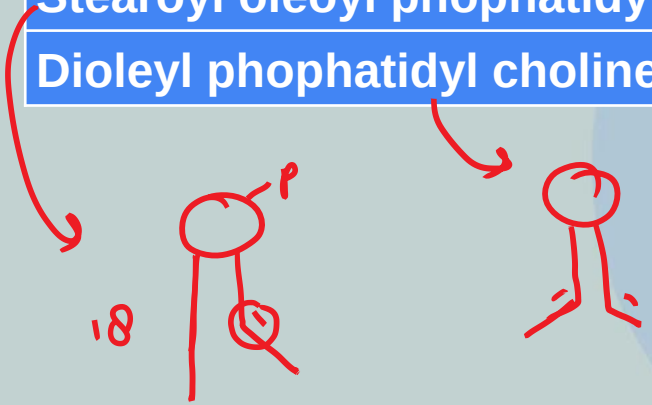
Tech.



Types of phosphatidyl choline	Tm (^{0}C)
Distearoyl phophatidyl choline (DSPC; Di 18:0)	+ 58
Dipalmitoyl phophatidyl choline (DPPC; Di 16:0)	+ 41
Stearoyl oleoyl phophatidyl choline (SOPC, 18:0, 18:1)	+ 3
Dioleyl phophatidyl choline (DOPC; Di 18:1)	- 22

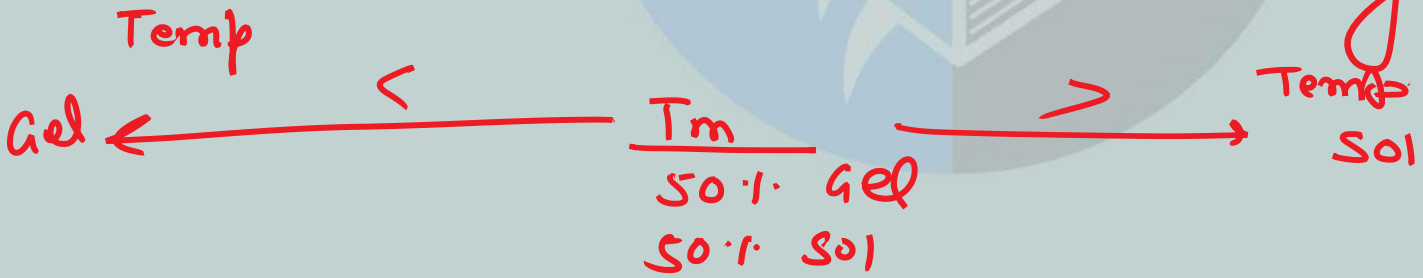
chain length

unsaturation



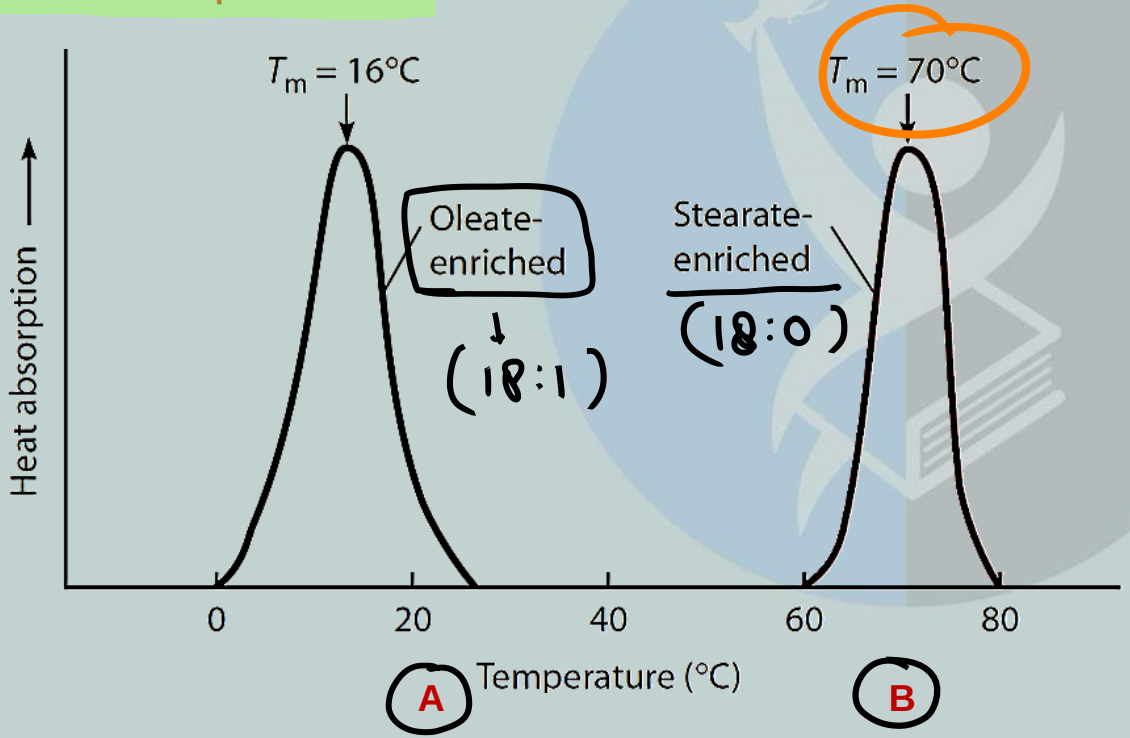
Tm of Lipids and adaptation

- P.m. Remain in Quasifluid state
  (Niter liquid, nor solid)
  - attain Near its Tm
  - Required to Perform its function.
  - P.m. act as permiability barrear



Apply Your Mind

Which of the following case (A or B) represent wheat plant adapted to low temperature?

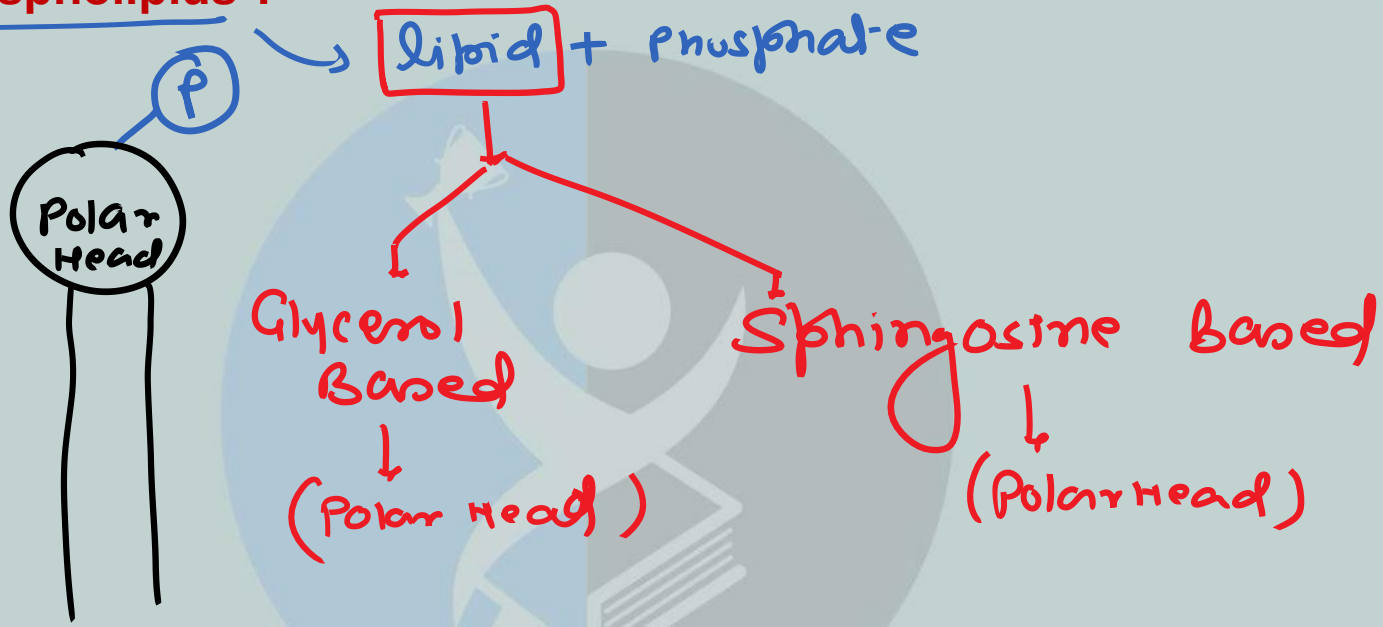


⇒ Membrane lipid

↓

Most common are phospholipid

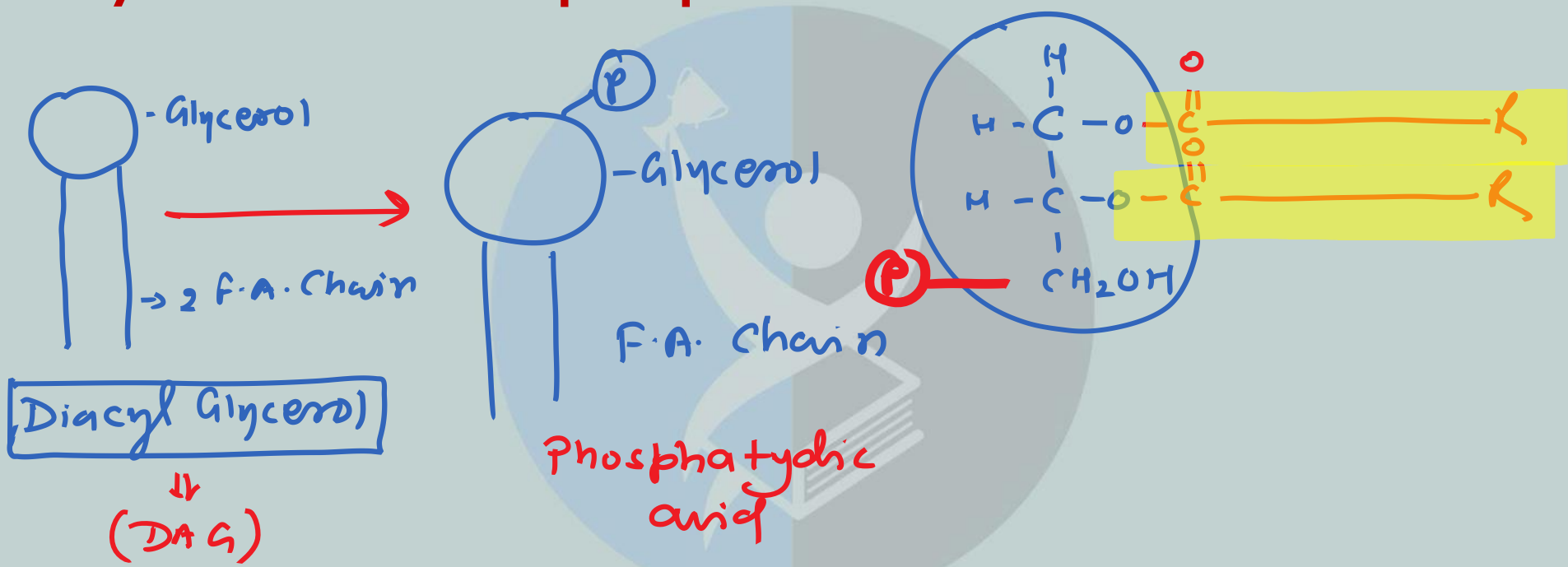
What are Phospholipids ?



Membrane Lipids

1. Phospholipids → (1) Glycerol based (2) Sphingosine based
2. Glycolipids
3. Sterol

Glycerol Based Phospholipids



MAG

[monoacyl Glycerol]

↓

Role in Signalling

DAG

[Di-acyl Glycerol]

↓

- most common in P.M.
- Also role in Signalling

TAG

[Tri-acyl Glycerol]

↓

Formation of Fat droplet

K/a Glycerosomes

↓

+nt in Adipose Tissue

Glycerol based Phospholipid

Phosphatidic acid

Bulky Group] ↑se Polarity

if Polarity ↑ or Bulkyness ↑se

↓

Non polar Tail length ↑se

Glycerol based phospholipid

Phosphatydic acid + Ethanol amine = Phosphatidyl Ethanolamine

n + Inositol = Phosphotidyl Inositol

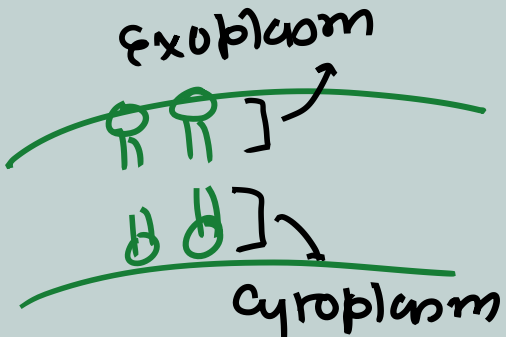
n + Choline = Phosphotidyl Choline

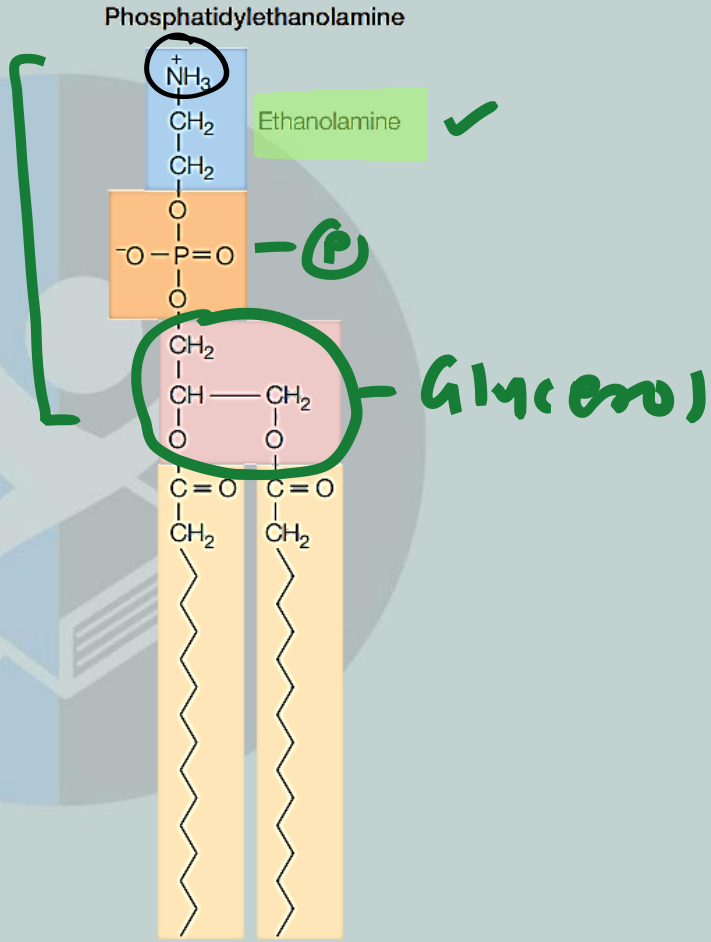
n + Serine = Phosphotidyl Serine

Phosphatidyl Ethanolamine

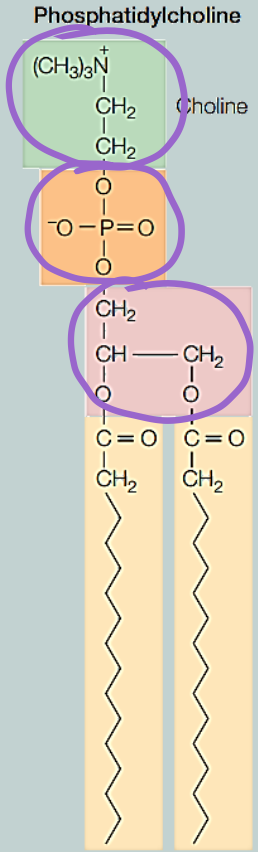
- most Abundent in Bacterial P.M.
- tnt toword Cytoplasmic Phase of P.M.

Polarity ↑



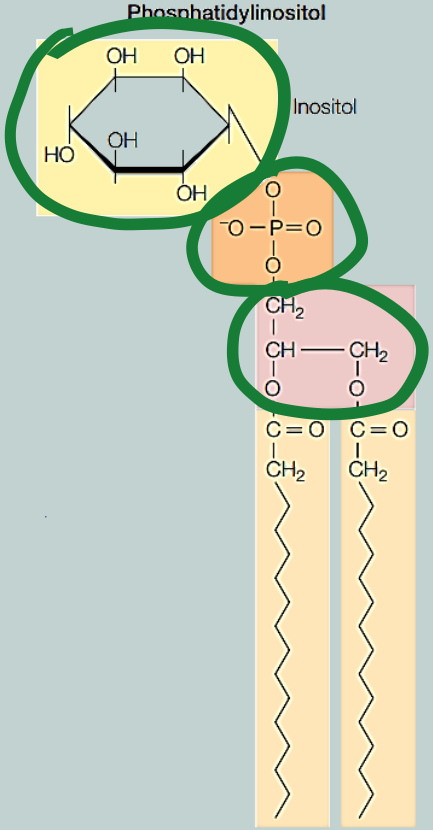


Phosphatidyl Choline



- tnt in Abundance toward the Exoplasmic phase of p.m.
- − nt in Bacteria

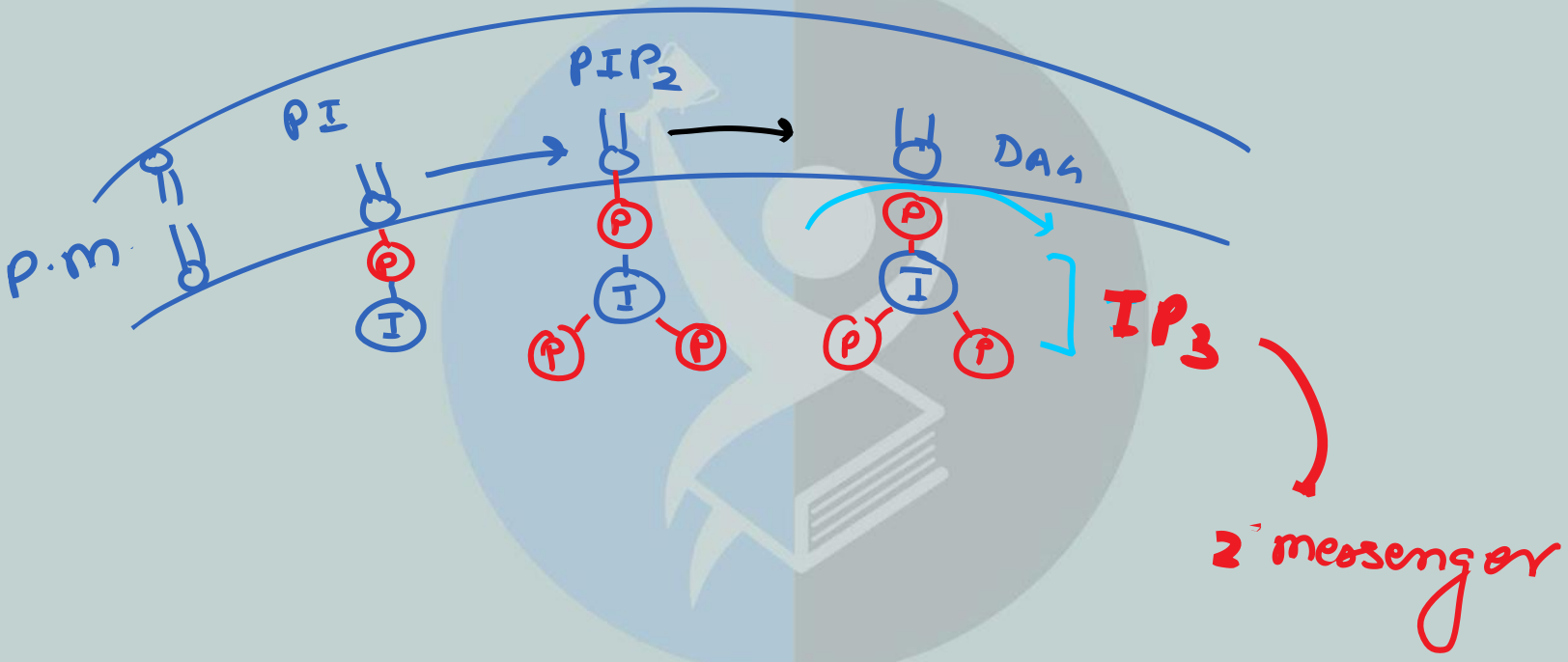
Phosphatidyl Inisitol [PI]



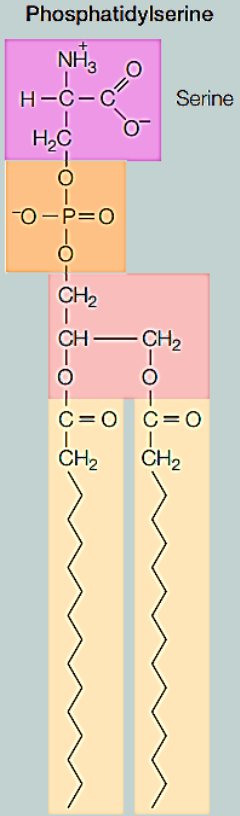
- Net -ve Charge
- Abundence toward Cytoplasmic Phase
- Involve in Signalling

→ PI ⟶ PIP_2 ⟶ DAG + IP_3

DAG: 2° messenger


P.M
PI
PIP2
DAG
IP3
2° meesenger

Phosphatidyl Serine



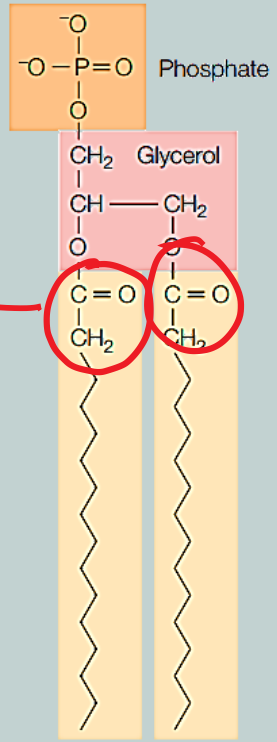
→ Net -ve charge

→ -nt in Bacteria

• ≈ 99% -nt toward Cytoplasmic Phase of P.M.

if PS flipped out → act as "eat me signal" ↓ Apoptotic signal

Phosphatidyl Glycerol



mostly ester bond hai
b/w D-Glycerol and F.A chain
But Exception → Plasmalogen
ether bond hai at C1

Sulfolipid

- Glycerol based
- Contain Sulfur as functional Group
- Play imp. role in Sulfur Cycle of plants

Cardiolipin → +nt in inner membrane of mitochondria

- act as marker for mitochondrial membrane

→ also +nt on Bacterial PM

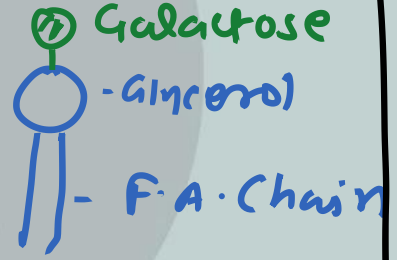
Phospholipid

Glycerol Based

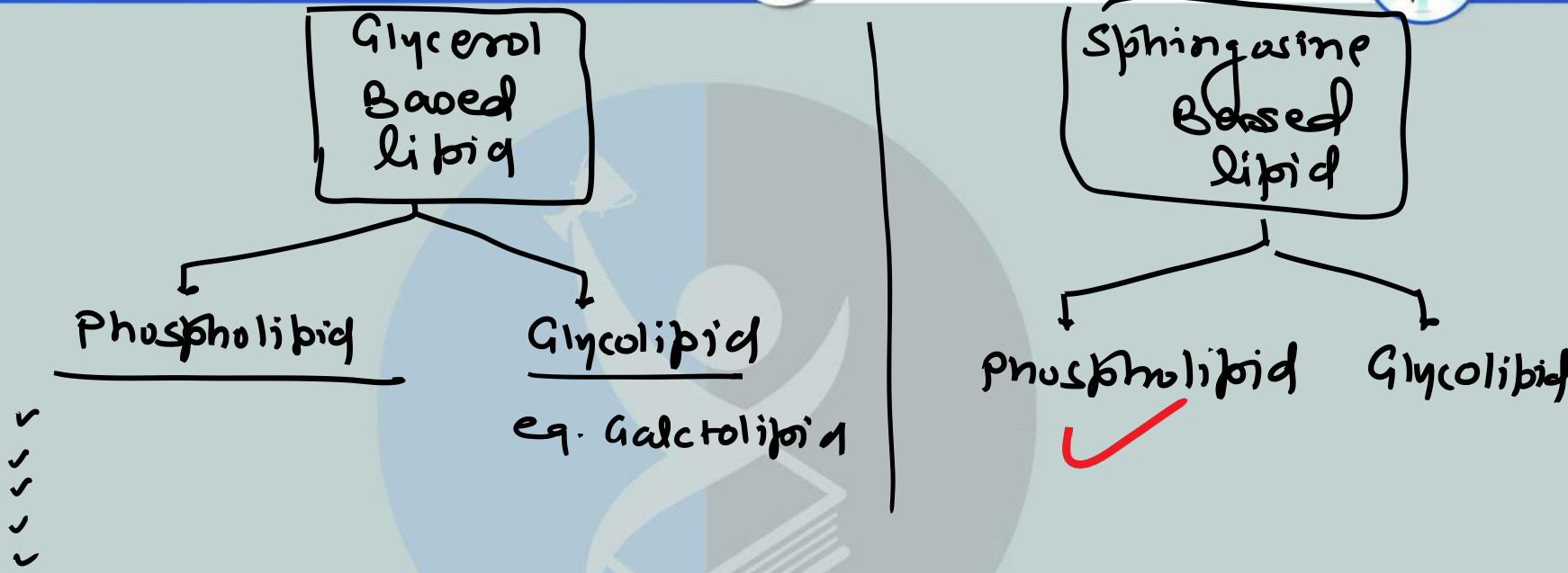
- PS, PE, PC, PI
- Sulfolipid
- Cardiolipin
- Plasmalogen

Glycerol based Glycolipid

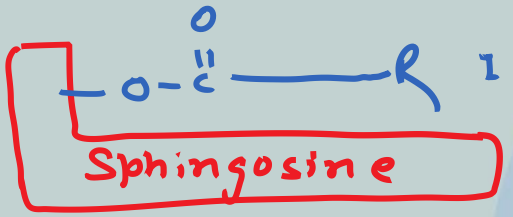
eg - Gactolipid



Ant in Plants.


Glycerol Based lipid
Phospholipid
Glycolipid
eg. Galctolipid
Sphingosine Based lipid
Phospholipid
Glycolipid

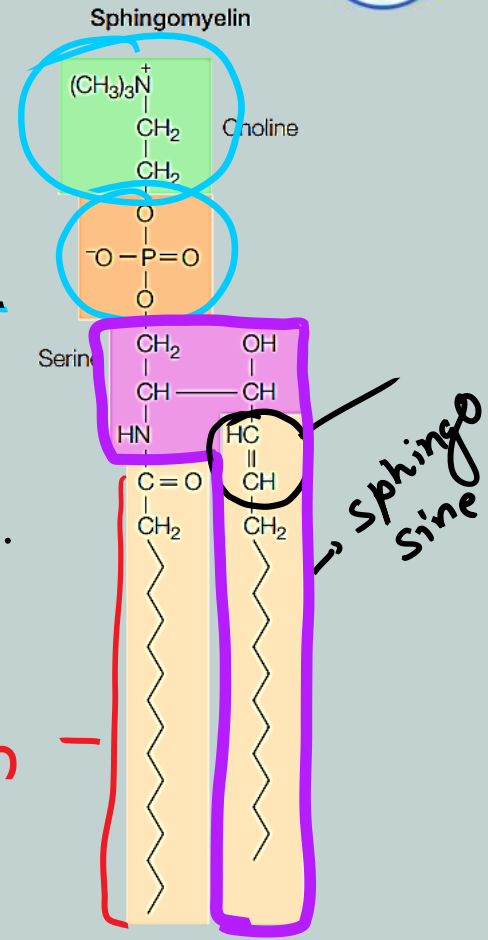
Sphingosine Based Phospholipids



F.A chain

Ceramide

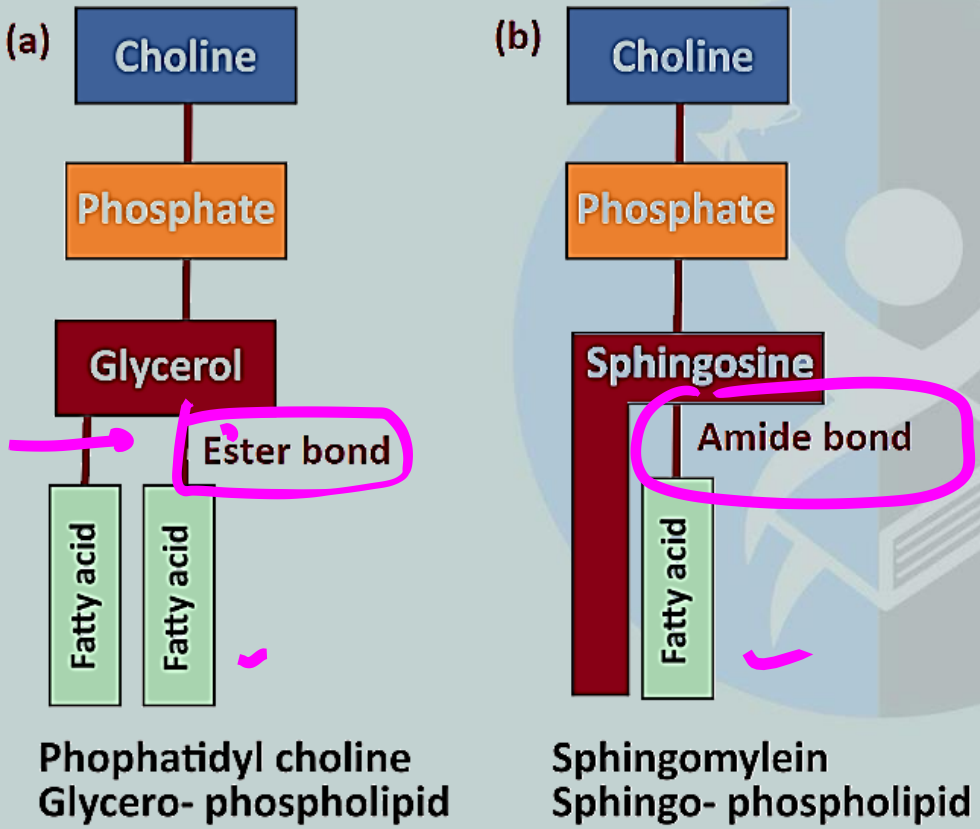
Phosphocholine



→ Sphingomyline = discovered in myline sheath.

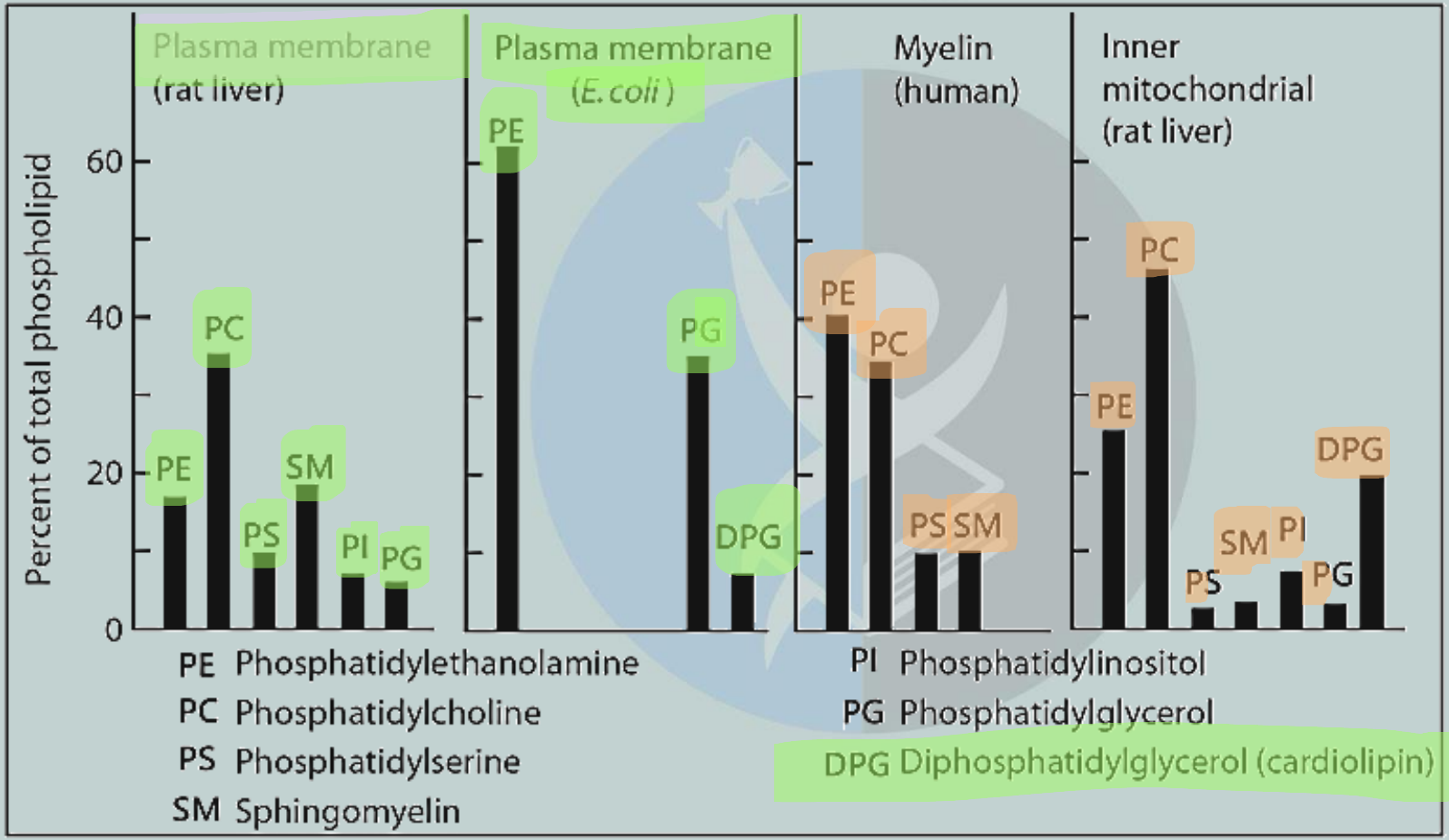
Ceramide + Phosphocholine = Sphingomyline

Sphingomyelin and Phosphatidyl choline

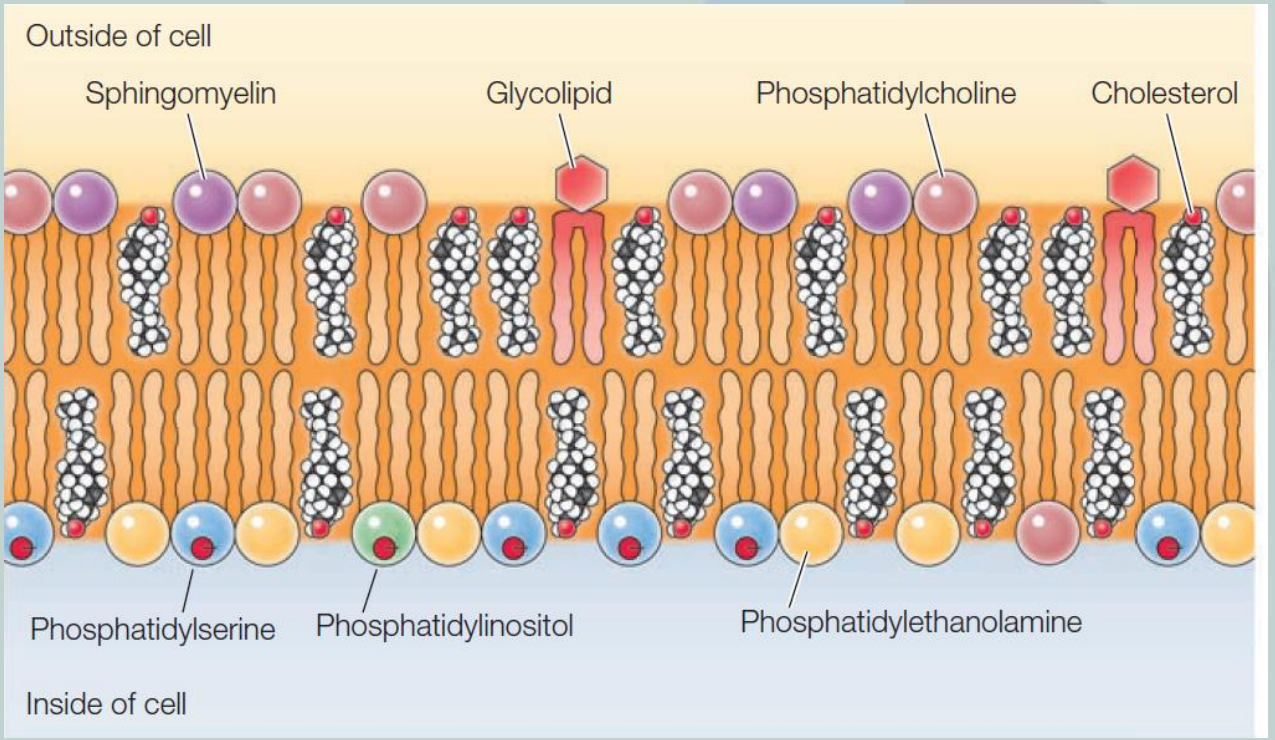


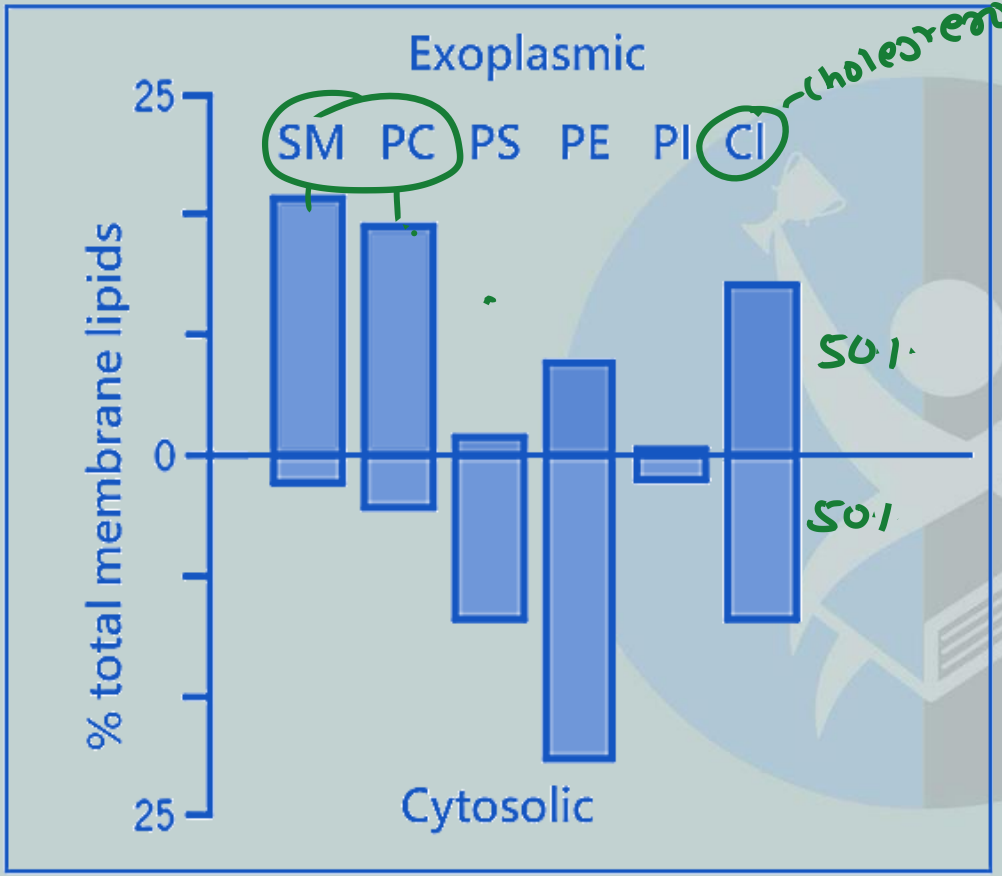
Phophatidyl choline
Glycero- phospholipid

Sphingomylein
Sphingo- phospholipid


Plasma membrane (rat liver)
Plasma membrane (E. coli)
Myelin (human)
Inner mitochondrial (rat liver)
Percent of total phospholipid
0
20
40
60
PE
PC
PS
SM
PI
PG
DPG
PE Phosphatidylethanolamine
PC Phosphatidylcholine
PS Phosphatidylserine
SM Sphingomyelin
PI Phosphatidylinositol
PG Phosphatidylglycerol
DPG Diphosphatidylglycerol (cardiolipin)

Phospholipids are asymmetrically distributed between the two halves of the membrane bilayer

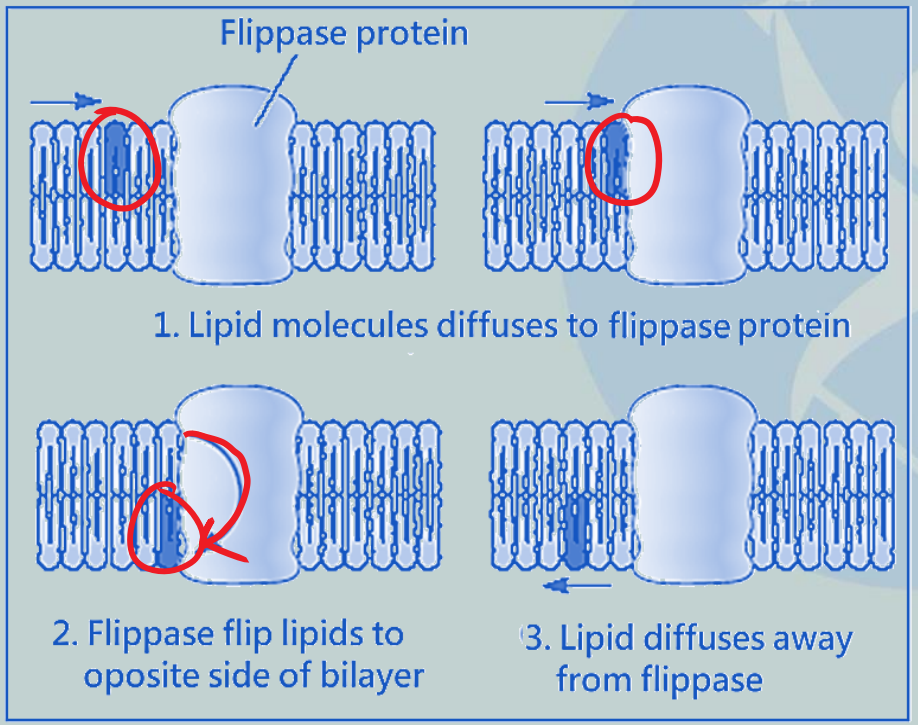




PC
SM
C.M
Exo
Cyto
E.S.I
PE
PS
PI

Flippases [P-Type Pump]

ATP- dependent translocation of the amino phospholipids from the extracellular to the cytosolic leaflet


Flippase protein
1. Lipid molecules diffuses to flippase protein
2. Flippase flip lipids to oposite side of bilayer
3. Lipid diffuses away from flippase

Floppases (ABC Transporter)

ATP-dependent trans location from the cytosolic to the extracellular leaflet.

Scramblase

Moves any membrane phospholipid across the bilayer down its concentration gradient.

Note → Flippase & Floppase +nt on Golgi & P.M

→ Scramblase +nt on SER membrane

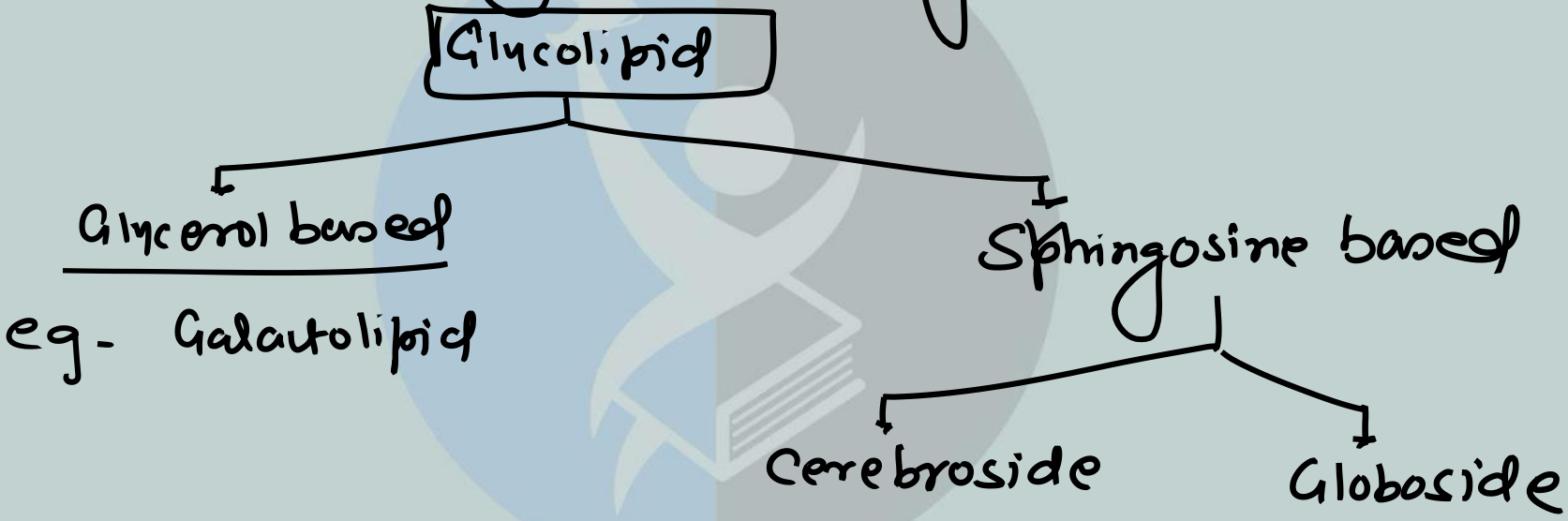
→ lipid Biosynthesis - occurs on SER membrane Toward Cytoplasmic phase

→ SER membrane shows symmetrical distribution

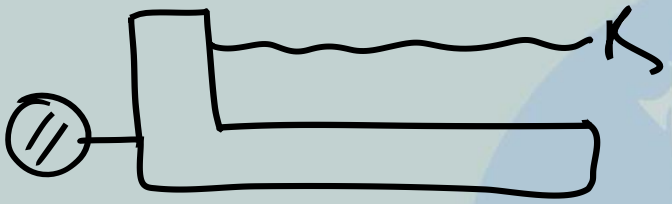
of lipid across SER Bilayer
due to trce of Scrambalase

What are Glycolipids?

↳ contain Sugar insted of Phosphate



Cerebrosides (only 1 sugar with ceramide)



Sugar
1
(Glucose or Galactose)

↓

K/A Glucocerebroside or
Galactocerebroside

Gangliosides

Ceremide + Oligosaccharide

↓

Contain at least one Sialic acid

↓

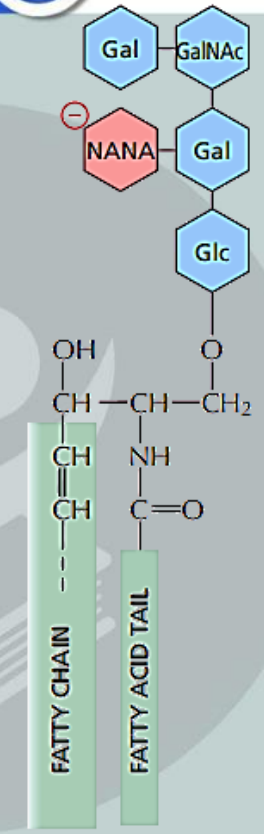
NANA

↓

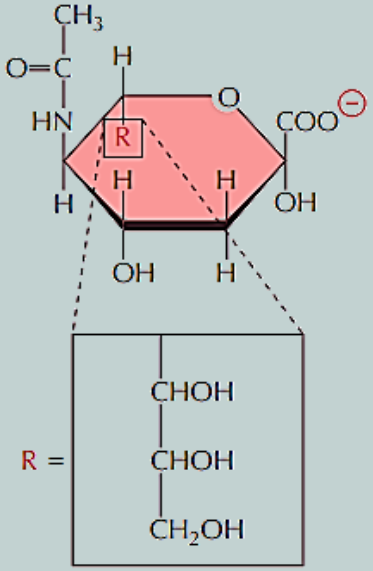
(N-acetyl Neuraminic acid)

↓

K/a monosialate



(B) G_{M1} ganglioside



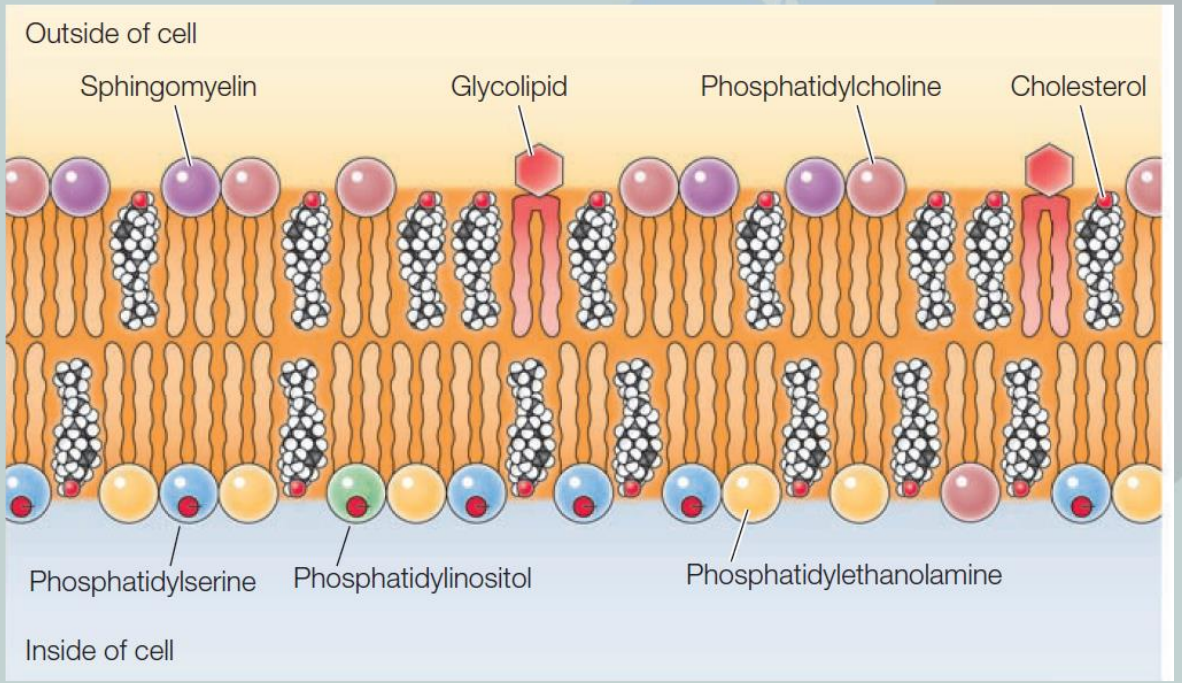
(C) a sialic acid (NANA)

- Gm Ganglioside → various type
  - Gm_1, Gm_2, Gm_3
    - Based upon electrophoretic mobility
- Gm_1 Ganglioside act Receptor for influenza virus
- Sialic acid Play Role in cell-cell Recognition.
- act as Blood Group determinents

GM3 Ganglioside: Receptor for Cholera toxin

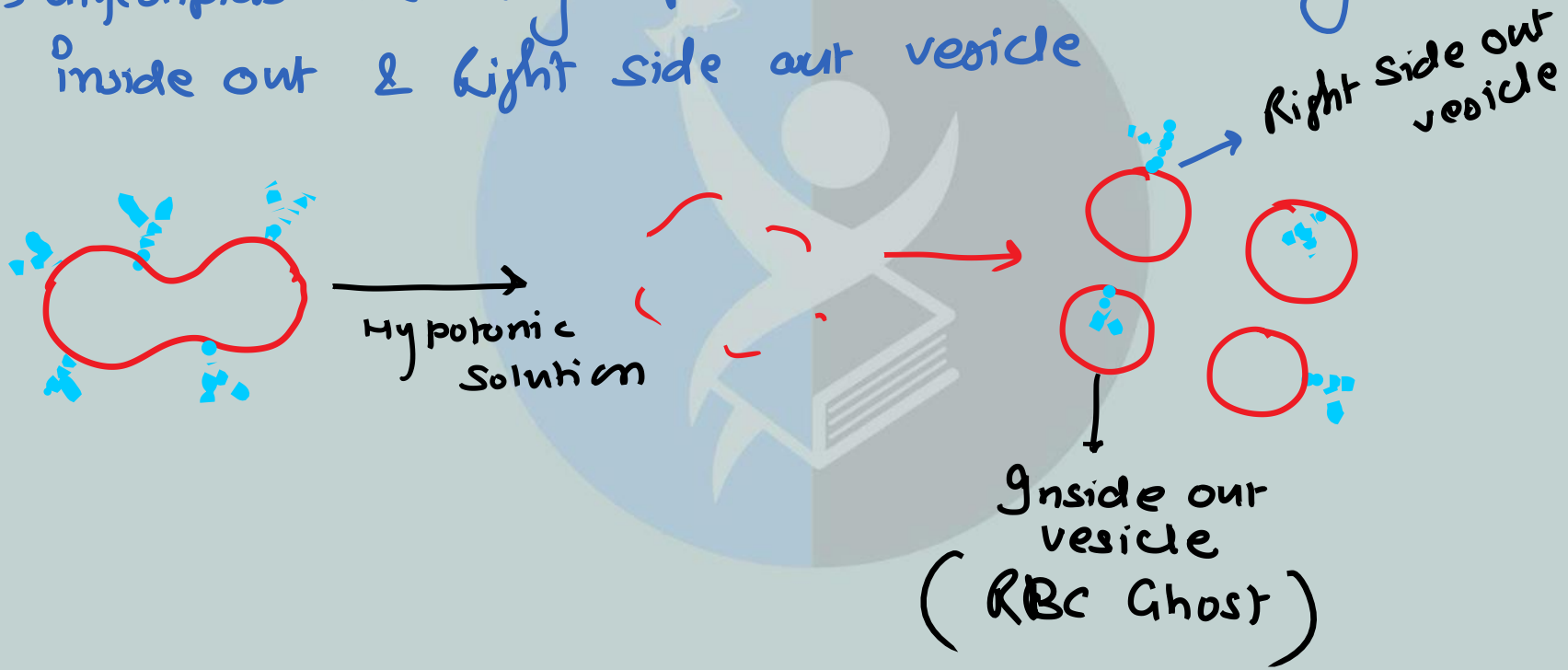
Glycolipids shows absolute asymmetry

↳ only int toword Exoplasmic Phase.



Membrane fragment: Inside-out Vesicles/Right Side out vesicles

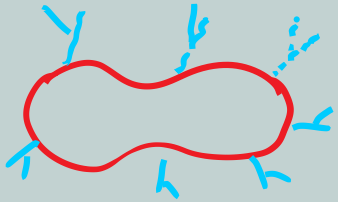
-> Glycolipids are very imp. determinants to recognize inside out & Right side out vesicle

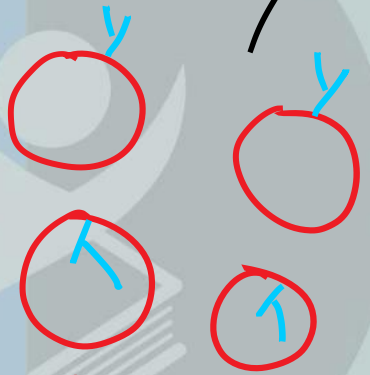


How you can confirm Phosphotidyl serine is located on cytosolic face ?

Annexin V → Binds with PS

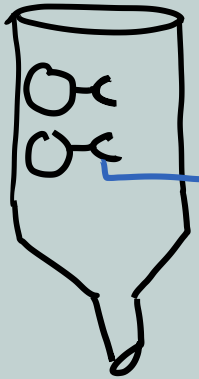
(Red)



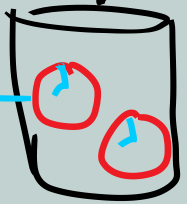


Binds with Annexin V

Inside out vesicle



lectin Column

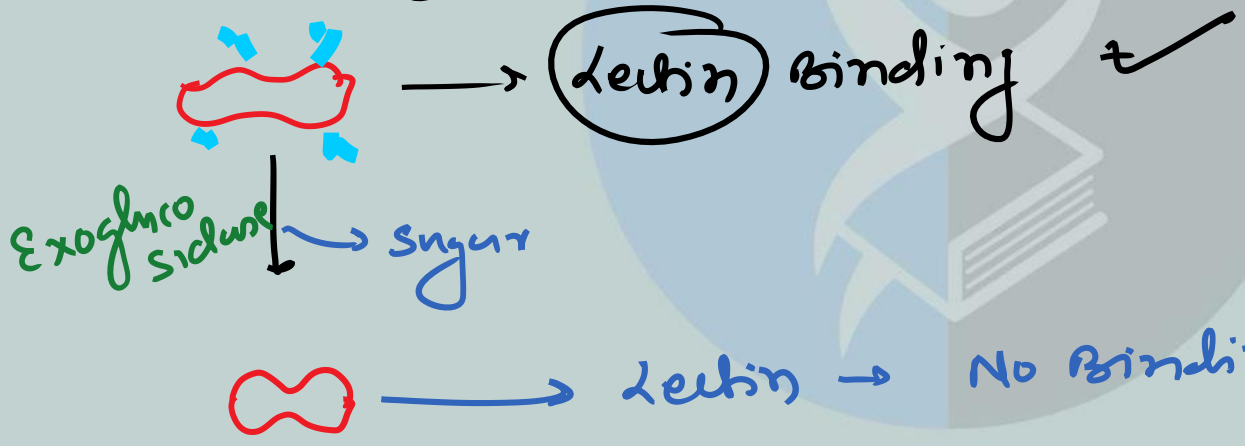


lectin

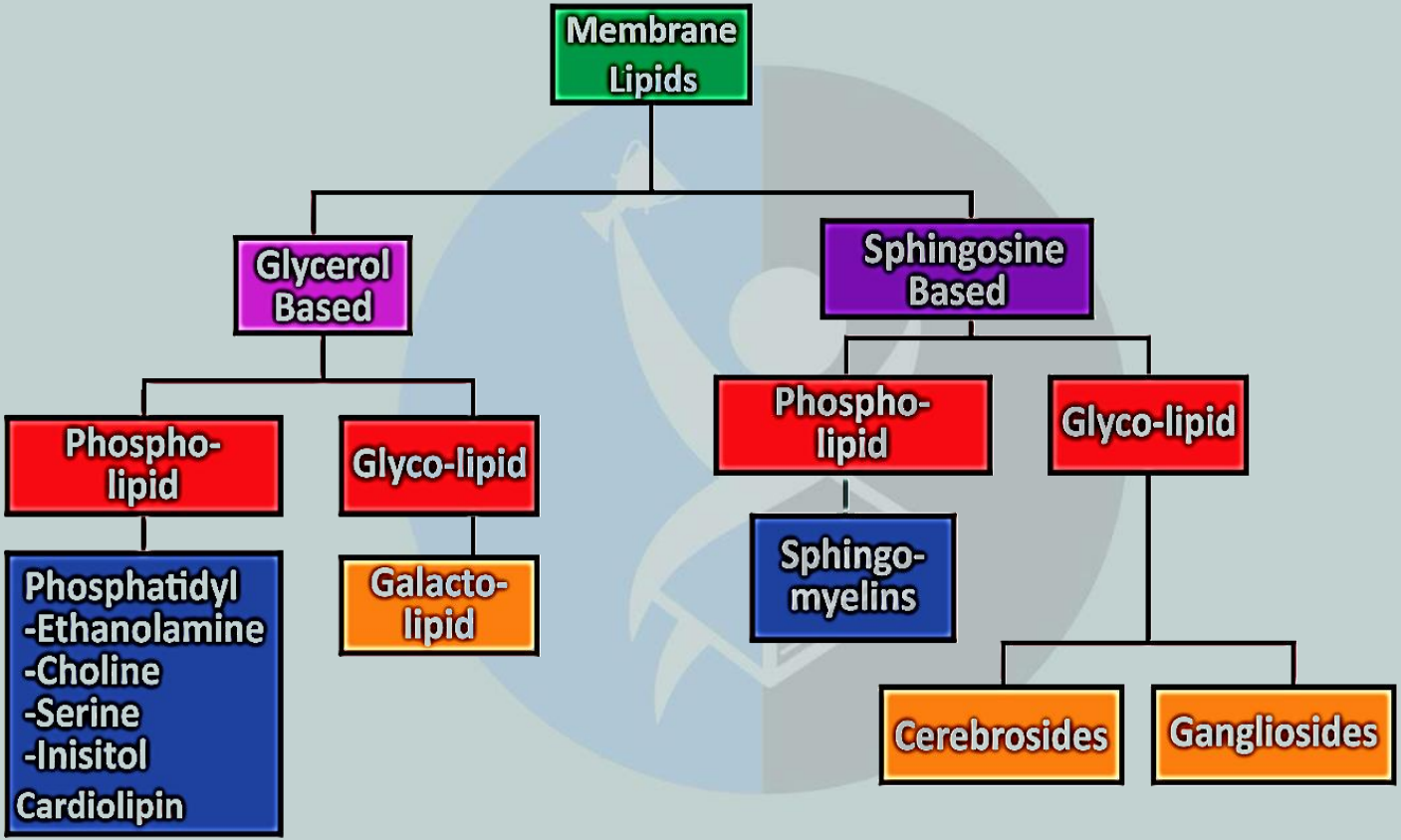
Protein · Binds with sugar

How you can confirm Ganglioside (asialo-GM_1) are on exoplasmic sides?

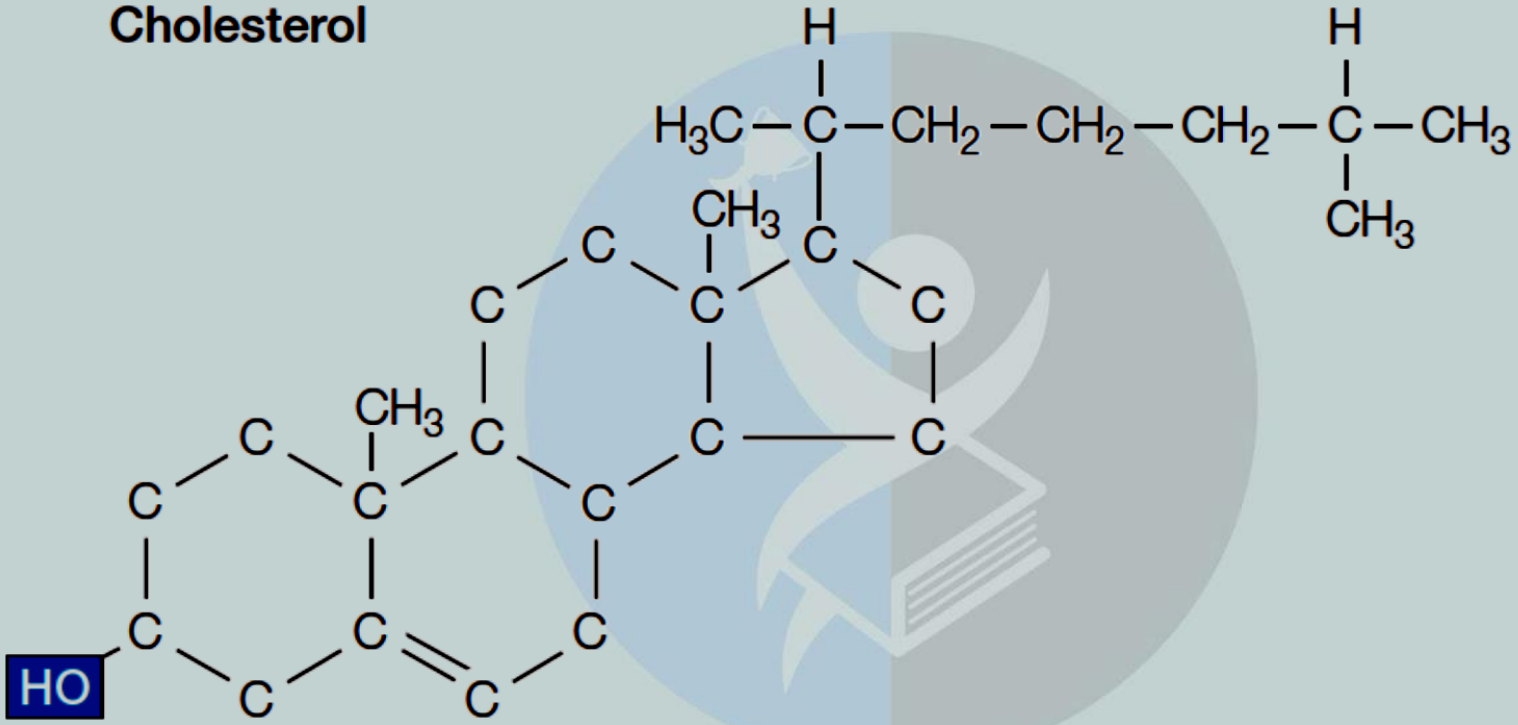
- Galactose Binding lectin
- Exoglycosidase

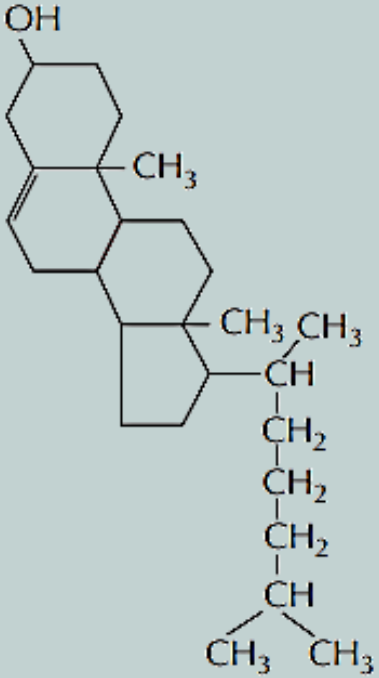


Galactose binding lectin
Exoglycosidase

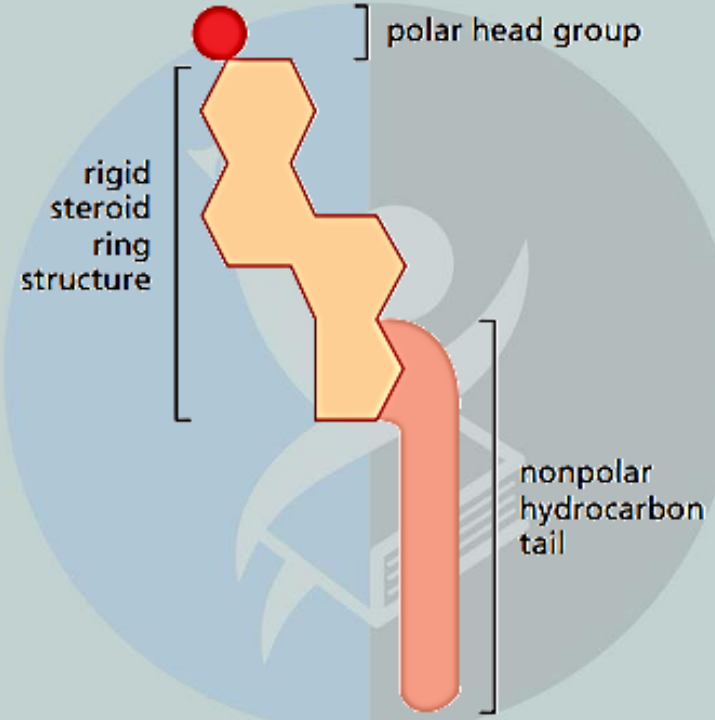

Membrane Lipids
Glycerol Based
Sphingosine Based
Phospho-lipid
Glyco-lipid
Phospho-lipid
Glyco-lipid
Phosphatidyl
-Ethanolamine
-Choline
-Serine
-Inisitol
Cardiolipin
Galacto-lipid
Sphingo-myelins
Cerebrosides
Gangliosides

Cholesterol




OH
CH3
CH3 CH3
CH
CH2
CH2
CH2
CH
CH3 CH3

(A)


polar head group
rigid steroid ring structure
nonpolar hydrocarbon tail

(B)

(C)

Role of Cholesterol?

- Provide membrane Rigidity
- limit lipid movement
- has more affinity with Sphingolipid
- Cholesterol fills the void space b/w 2 Sphingolipid

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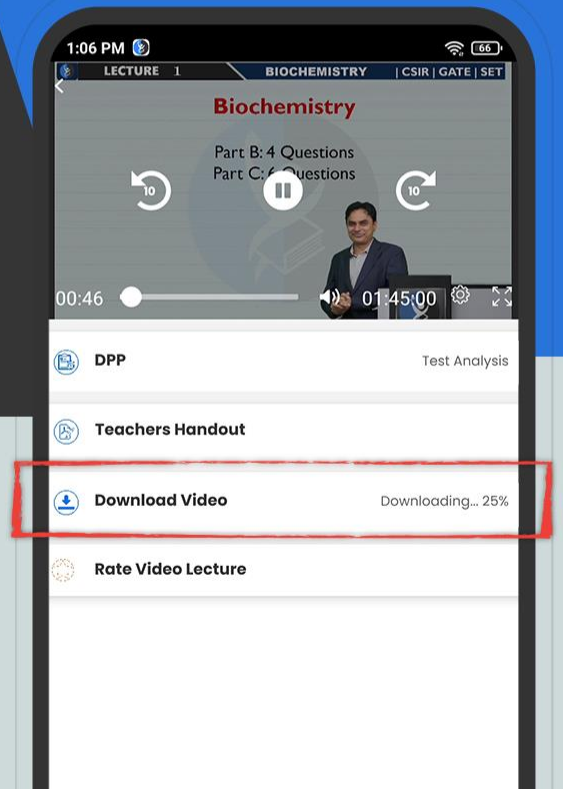

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